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STUDY OF THE SEWAGE DISPOSAL PROBLEM
AT FORT WORTH, TEXAS, FROM THE STAND-
POINT OF ODOR NUISANCE ALLEVIATION IN
•RESIDENTIAL DISTRICTS

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Public Health Service
Cincinnati, Ohio

14 February 1938

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~~A REPORT ON~~ STUDY OF THE SEWAGE DISPOSAL PROBLEM AT FORT
WORTH, TEXAS, FROM THE STANDPOINT OF ODOR NUISANCE ALLEVIA-
TION IN RESIDENTIAL DISTRICTS.

By
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Cincinnati, Ohio.

February 14, 1938.

At the request of the State Health Officer of Texas and of municipal authorities of the City of Fort Worth, Texas, made to the Surgeon General of the Public Health Service, the writer was detailed to confer with city officials at Fort Worth and make a study of the odor nuisance problems created by sewage treatment devices in use in the City.

During the week of January 23rd an inspection was made of the environs of Fort Worth with Mr. Chester Cohen, Stream Pollution Engineer of the Texas State Board of Health and Mr. W. A. Mahlis, Chief Chemist of Fort Worth. This inspection included the municipal sewage disposal plant, the combined preliminary screening and settling plant of the large packing houses, the individual septic tanks of each small packing house, the Marine Creek area and the Trinity River. The inspection was made following a period of wet weather which resulted in high sewage flows due to surface water infiltration into the sewers. Consequently the sewage then arriving at the municipal disposal plant was in a fresh condition. Practically no odors were produced at the plant and no complaints of odors were received during the visit. All of the information on odor nuisance upon which this report is based was, therefore, obtained from various municipal employees and from the records of odor intensity factors



at the plant units and odor complaints which have been kept by Mr. Mahlie and his assistants. In addition, an examination of the sewage disposal plant operation records was made and copies of all operating records and reports pertinent to the odor alleviation problem were furnished by the City and have been used in the preparation of this report.

The original sewage disposal plant, which consisted of Imhoff tanks and sprinkling filters, was designed for a population of 125,000 and had a capacity of 7.5 million gallons per day. This plant was put into operation in April, 1924. It was located on the north side of the Trinity River in a sparsely settled area on the eastern edge of the City about six miles from the two large packing houses.

A primary treatment plant providing screening and clarification was completed by the packing industry in 1925, effluent from which was discharged to the city sewers. It was then found that the original municipal treatment plant was too small to handle the additional burden of the strong packing house waste. In 1927, Pearce, Greeley and Moore recommended an enlargement of the plant to a capacity of 16 m.g.d. In 1928 the enlargement was designed by Hawley, Freese and Nichols and this construction was completed in 1929. The enlargement included the screen and incinerator house, extension of the pump house, one additional Imhoff tank and five aeration tanks with a capacity of three million gallons. Three secondary settling tanks, four dosing tanks, one sprinkling filter, one additional final settling tank and three covered separate sludge

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digestion tanks were also constructed at this time. The plant improvements cost \$780,000.

In 1936 additional improvements which cost \$154,000 were made on the plant. These improvements consisted of the installation of one 36 inch communitor, the conversion of two Imhoff tanks into two straight line primary settling tanks with mechanical equipment and the construction of two additional sludge digestion tanks with mechanical equipment. (Figure 1 shows a flow diagram for the present plant).

The Odor Problem.

In 1930, shortly after the enlarged plant was placed in service, odor troubles were encountered and complaints of odors were received from residents of the City. The odor complaints were confined to three sections of the City nearest the plant: (a) the Riverside section located northwest of the plant with a population of about 8,000; (b and c) the Polytechnic and Sycamore Heights sections across the river to the south with a population of about 18,000. Residents of these sections organized a number of years ago for the purpose of getting the City authorities to do something toward abatement of the odor nuisance. Although the municipal authorities have been working continuously to solve the problem it remains essentially unaltered at the present and is an acute issue with the residents of the districts involved.

In February, 1932, Mr. D. L. Lewis, City Engineer, and Mr. W.A. Mahlie, City Chemist, reported on the odor situation and made the following recommendations with a view of reducing the odors:

1. Install chlorine and lime treatment,
2. Chlorinate supernatant liquor from digesters,
3. Change Inhoff tanks to sedimentation tanks,
4. Dilute raw sewage,
5. Install sludge pump,
6. Construct additional digesters and equipment,
7. Correct air distribution in aeration tanks,
8. Install measuring devices.

Immediately after this Dr. F. W. Mohlman, Chief Chemist of the Sanitary District of Chicago, and Mr. Samuel A. Greeley, of Pearse, Greeley and Hansen, studied the odor problem at Fort Worth. Mr. Greeley reported that the odor problem depended in large measure upon the following three elements:

- a. The characteristics and condition of the sewage,
- b. The routine of plant operation,
- c. Needed additional structures or changes in existing structures.

Mr. Greeley concluded that the sewage contained a relatively large amount of sulphates and that the warm temperature of the sewage during the long time of flow required to reach the treatment plant caused the sulphates to be reduced to H_2S by sulphur reducing organisms. He advised an attack upon the sulphur reducing organisms rather than upon the H_2S after it was formed and pointed out that the point of application of the sterilizing agent was an important consideration. This report approved of the program of remedies proposed by Mr. Lewis and Mr. Mahlie and suggested the recording of the odors at the plant as to source, nature and intensity.

Since 1932 all of the recommendations of Lewis and Mahlie have been carried out with the exception of the correction of the air distribution. A number of experiments and variations in method of operation of the plant have been made, a complete record of the operating results has been obtained and daily records of the source and intensity of the odors at the plant have been kept.

Brief Review of Experimental Operation Tried with the View of
Odor Alleviation.

I. The raw sewage was chlorinated at the grit chamber with average doses of 6.3 to 9.5 p.p.m. of chlorine for the period from July 13 to August 20, 1931, without any noticeable reduction in odor.

II. Digester supernatant overflow liquor was chlorinated with an average dose of 88 p.p.m. for the period of March 2 to June 10, 1932, without any apparent reduction in odors.

III. The combined packing house and domestic sewage was treated with chlorine and hydrated lime applied to the interceptors at a point about 3-1/2 miles from the plant. This experiment was continued from March 21 to October 4, 1932. The chlorine was fed from ton containers through four chlorine machines at a maximum rate of 1620 pounds per day. The average dose of chlorine for the period was 12.04 p.p.m. The average ratio of chlorine to lime was 1 to 1.21. The results of this experiment did not meet expectations.

IV. Ferric chloride was applied to the raw sewage at the same point as in Experiment III. The ferric chloride was prepared by chlorinating scrap iron in a plant built on the site. An average dose of 6.8 p.p.m. of ferric chloride was added to the sewage from October 5, 1932 to January 7, 1933. This experiment produced no odor reduction at the plant but was detrimental to the plant effluent

in that it changed the clear effluent produced formerly to a nasty looking black color apparently due to the formation of colloidal FeS .

V. Chlorination and lime treatment was carried out at the grit chambers of the plant from February 6 to September 30, 1933. During this period 217,600 pounds of hydrated lime and 217,641 pounds of chlorine were used but odor complaints were still received. It is interesting to note here that during the two year period that the various chlorination experiments at Fort Worth were carried out about 222 tons of chlorine were used.

Besides the experiments listed above, chlorination was also tried on the effluent of the secondary tanks before going to the filters and on the secondary tank sludge returned to the aeration tanks. Neither of these experiments produced any material effect.

VI. Dilution Experiment. About four million gallons per day of raw water from Lake Worth were added to the sewage from July 11 to September 30, 1933. This experiment was run simultaneously with chlorination at the grit chamber as stated in V. It is noted that even with dilution and chlorination numerous complaints of odors were received.

VII. The packing house sewage was bypassed into the river and only domestic sewage was treated at the plant from December, 1933 to August, 1934. The exclusion of the packing house waste from the plant did not eliminate all of the odors at the plant. There were, however, no odor complaints received about the plant. During this period there was a marked improvement in the quality of the effluent which reached a very high standard. However, the river became very

obnoxious as a result of discharge of untreated packing wastes and complaints were received from residents of Riverside and from persons as far downstream as Grand Prairie.

VIII. Sewage effluent from the Imhoff tanks was bypassed around the aeration tanks and secondary settling tanks and applied directly to the sprinkling filter from January 1, 1935 to July 1, 1937. The cessation of operation of the aeration and secondary tanks reduced the quality of the effluent somewhat during the first year of plant operation in this manner, but no complaints regarding the River were received. During the second year the quality of the effluent was lowered slightly more, conditions in the river became bad and complaints from residents near Grand Prairie were received. The odor indices recorded at the plant during this entire period of operation were reduced and it is reported that no odor complaints regarding the plant were received.

IX. The primary tank effluent was aerated and applied directly to the sprinkling filters from January 1 to July 1, 1937. This method of plant operation improved the quality of the plant effluent but also increased the odor index at the plant.

X. The primary tank effluent was aerated without sludge return, the aerated mixture was settled in the secondary tanks, and the effluent applied to the sprinkling filters from ~~July~~ 1, 1937 to the present. This method of operation improved the quality of the effluent but also increased the odor index at the plant.

The above brief summary of the principal experiments and methods of plant operation that have been tried during the past seven years



without material success indicate that the odor control problem at Fort Worth is a very difficult one. In addition to the above experiments very complete studies of the hydrogen sulphide content of the sewage and of the effluents from the various plant units have been made. The summaries of these results are shown in Table I. Table II shows the hydrogen sulphide content and the odor intensity record of the primary tank, aeration tank, secondary tank and sprinkling filter from October 1, 1936 to September 30, 1937. The records indicate that these four plant units are the major odor producers. The only other plant unit that produces any appreciable odor is the sludge lagoon which will have to be carefully operated during the summer months. The records indicate that, for the purpose of this report, the sludge lagoons may be neglected and attention focused on the principal plant units listed above.

Conclusions Regarding the Causes of Odor Difficulties as Indicated by the Record.

1. The principal difficulties encountered are due to the characteristics and condition of the sewage upon its arrival at the treatment plant. The high biochemical oxygen demand of the sewage and the time of flow to the plant will affect its suitability for treatment by the methods provided.

At Fort Worth, the high B.O.D. of the sewage, the sewage temperature, the extremely high bacterial population due to the warm packing house waste, the long interceptor and time of flow to the plant and the number of sewage siphons all tend to stimulate anaerobic decomposition and hasten septicity. Hydrogen sulphide is a product of anaerobic decomposition of sulphur compounds and serves as a good indicator of the degree of anaerobic decomposition accomplished.

Anaerobic decomposition produces alkaline nitrogenous compounds which are malodorous and apparently difficult to treat by tank aeration and other aerobic processes without odors being produced. Treatment could be more satisfactorily accomplished without odors by preventing anaerobic decomposition.

2. It should be apparent from the various methods of plant operation tried, that the routine of plant operation is not the cause of the difficulties encountered at Fort Worth. The routine followed at the plant at present is apparently adequate and satisfactory except for two minor details. First it seems inadvisable, in a plant where it is difficult to prevent the production of odors due to anaerobic decomposition of very strong sewage, to eliminate fine screens and the incineration of screenings and introduce comminators thereby adding load and opportunity for odor production to the plant units. Unless difficulties with the former method of screenings disposal were encountered, this change does not seem wise from the standpoint of odor control. The second item of plant operation that seems questionable is the return of the supernatant liquor of the digester to the primary tanks. This practice appears to be detrimental to the satisfactory operation of aerobic treatment processes and certainly increases the probability of odor production in the aeration tanks and sprinkling filters.

3. From the study of the operation records, it would appear that additional plant capacity at the site of the present plant is not urgent. It would be difficult to justify the expense of further extensive treatment structures on the present site for they would probably fail to accomplish any reduction in odors which is the primary

purpose of plant improvement. The primary tanks seem adequate for all ordinary flows though some additional capacity may be desirable for peak flows. The secondary tanks have an adequate capacity. Because of the peculiar performance of the aeration tanks some discussion of these is probably in order.

The data presented on the operation of the aeration tanks seem to indicate that the principal causes of the odors are the end products produced by the anaerobic fermentation taking place in the sewage during its travel to the plant. The high B.O.D. of the sewage and the packing house waste component do not appear to be the cause of the difficulty, because at other localities satisfactory activated sludges have been developed from even more concentrated sewages containing packing house wastes. The plant at Fort Worth, with an apparently adequate aeration and settling capacity has never developed an activated sludge. This means that a sludge capable of removing 70 per cent or more of the 5-day B.O.D. of the applied sewage during a 5 to 6 hour aeration period has never been developed. Various aeration periods for mixed liquor and for the return sludge and various proportions of return sludge have been tried without avail. It has been definitely shown at Fort Worth that aeration of return sludge for various periods from 1 hour to over 500 hours did not produce activated sludge. For the year ending September 30, 1934, the mean 5-day B.O.D. of the sewage applied to the aeration tanks was 200 p.p.m. and the mean B.O.D. of the secondary settling tank effluent was 151 p.p.m. This represents an average B.O.D. removal due to aeration and settling of about 24.5 per cent. The maximum removal for any month that year was about 39.0 per cent and the

minimum removal was 12.0 per cent for these units. This was accomplished with an average aeration time of 5.8 hours and with various return sludge aeration periods of from 27 to 60 hours (excepting one month when a very long sludge reaeration period was tried). This performance indicated definitely that the sludge in the tanks was not an activated sludge for it could not handle satisfactorily substrates with an average 5-day B.O.D. of 200 p.p.m. in 6 hours. The fact that during the years that the plant was operated no better performance of the sludge in the aeration tank was obtained would seem to indicate that character of the substrate (due to earlier anaerobic decomposition or some other factor and not simply high B.O.D.) going into the aeration tanks was unsuitable for producing an activated sludge. It is true that the air distribution in the aeration tanks is very bad at present. This condition undoubtedly needs correction but the failure to produce an activated sludge at any time can scarcely be attributed to faulty air distribution. That the aeration given is valuable in reducing the load on the filters and in helping to produce a final effluent of satisfactory quality is shown by the records even though activated sludge performance has never been attained. The evidence seems to indicate that the aeration tanks have sufficient capacity and that it is very doubtful whether enlargement of these tanks would either effect activated sludge performance when operated with sludge return or reduce the odor difficulties.

Up to the present time when the sprinkling filter is operated on secondary tank effluent, a final effluent of satisfactory quality has been obtained. Under this condition of operation considerable

odor is very often produced by the sprinkling filter. The intensity of the odor is roughly correlated with the B.O.D. loading of the filter. The odor intensity is also apparently correlated with the total flow through the filter. When the filter dosing rate is 3 m.g. per acre per day or less, the odors are more pronounced than when the filter rate is higher than 3 m.g. per acre per day. It is evident from this observation that the operation and odor production of the sprinkling filter is also dependent on the condition of the sewage arriving at the plant.

A Suggested Program of Laboratory Study of Sewage and Sludge.

Before presenting proposals for odor alleviation it would seem desirable to suggest certain laboratory experiments that might be undertaken which would determine definitely whether or not it is possible to develop an activated sludge with the sewage arriving at the disposal plant. If it is found impossible or very difficult to develop an activated sludge with the plant sewage in the laboratory it could be concluded that further experimentation to obtain more satisfactory purification with the present aeration units would be futile, until such corrective measures were applied to the sewage as would make it suitable for aerobic treatment.

In the laboratory experiments the development of activated sludge could be attempted from the sewage arriving at the plant and from sewage collected from other points on the collecting system and rushed to the laboratory. The attempt to develop laboratory activated sludge could be made in 3 liter bottles operated on the fill and draw system. After the proper quantity of sludge, regard-

less of its appearance or other characteristics, from a single substrate source had been developed, a test to determine its efficiency in removing the biochemical oxygen demand of the substrate applied to it should be made.

It would seem desirable to repeat these activated sludge developments and substrate B.O.D. removal tests on fresh and plant sewage three or four times, over a three or four month period when odor difficulties are being experienced at the plant. Similar experiments should be carried out on fresh packing house wastes and fresh mixtures of packing house waste and domestic sewage taken from sewers near the packing house primary treatment plant to determine whether or not these sewages are capable of being treated readily by aerobic processes. For comparison with the results of these laboratory developed sludge experiments, substrate biochemical oxygen demand removal tests should be made using similar quantities of sludge obtained from the aeration tanks when dosed with plant sewage and fresher substrates.

The results of these experiments should indicate whether or not anaerobic decomposition occurring in the sewage during its passage through the interceptor to the plant was creating difficulties in the treatment process. If the difficulty is found to be due to the inherent composition of the sewage mixture and not to its anaerobic decomposition, the problem will require a different attack from that suggested here.

Suggested Program for Alleviation of the Odor Difficulties.

If the experimental work outlined above is conclusive and indicates that the septic character of sewage at the present plant is

the cause of the difficulties, two solutions seem possible:

1. Sterilization to slow up biological action and anaerobic decomposition during the time of flow to the present plant.
2. Installation of an additional treatment plant for parts of the city now too remote from the present works such as near the packing industry, etc.

The decision concerning which of these procedures should be adopted must depend upon a detailed study of the relative costs and other factors involved, including possibly the operation of an adequate experimental plant to ascertain the practicability of treating completely the fresh packing house waste by some satisfactory method.

Pending the completion of this preliminary work and decision concerning the most suitable permanent plan to be adopted, certain temporary measures are proposed any of which can be modified or eliminated when the results of the laboratory experiments suggested are obtained.

1. Improvement of operating procedures is undoubtedly needed at the present treatment plant for sewage from the small packing houses. It would seem desirable that a program for the proper operation of, and sludge removal from, these septic tanks should be worked out. This would seem important enough to warrant weekly inspection by a city health department inspector to see that these plants were actually being operated satisfactorily. In addition, the waste from the small packing houses combined with domestic sewage should be chlorinated at some point preferably just before reaching the larger main or interceptor. The volume of sewage here would

probably not be very large and the chlorine dose could be adjusted to give at least a .5 p.p.m. residual after a 30 minute contact period at all times. Any excess chlorine used here would be advantageous in assuring reduction of bacterial action on these strong wastes and deferring anaerobic bacterial decomposition for a longer period.

2. Application of chlorine to the effluent of the preliminary treatment plant of the large packers or possibly to the flow in the interceptor just below the entry of the sewage from their plant is suggested. Laboratory chlorination experiments upon five gallon samples of sewage at these points to determine the doses required, the bacterial reduction obtained, the time that septicity will be delayed with the dilution and reseedling encountered in passing to the plant and the suitability for treatment by aerobic processes in experiments as previously suggested could profitably be carried out first. The results of these experiments should indicate whether it would be best to chlorinate the packing house waste separately or combined with domestic sewage in the interceptor.

3. It is probable that the domestic sewage in some of the long sewer mains is also septic for a good part of the year. A study of the condition of the sewage reaching the interceptor from some of the long mains should be made. This study should include determinations of the dissolved oxygen, hydrogen sulphide and possibly the three minute oxygen consumed value of the sewage. Haworth(*) recommends the change in three minute oxygen consumed

(*) The Chlorination of Sewage for the Prevention of Septicity.
J. Haworth, Inst. of Sewage Pur. Jour., Part 1, p. 192 (1934).

value as a criterion of septicity. The dissolved oxygen should be determined by the short Winkler method on samples at the point where the samples are taken. Sewage from the most critical points located in this study should be tested for suitability of treatment by aerobic processes. Chlorination may be required at some point on one or two of these long mains during the warmest months of the year when the sewage flows are low. Consideration may also be given to chlorination of the sewage at the chlorine treatment plant located about 3-1/2 miles from the plant (which was used in the earlier experiments with lime and iron) in conjunction with the chlorination of the packing house sewage at its sources. It is generally considered(*) that chlorination at a pH of 7.0 is most effective as a sterilizing agent. As the pH value of the raw sewage during the past few years has usually been 7.4 or above, chlorination with chlorine water would seem to be the most effective and economical sterilizing agent. The indications are that the addition of lime in the present instance would make sterilization less effective.

To be successful, a program of chlorination of sewage in the mains and interceptors will have to be worked out which will prevent septic sewage from reaching the plant, because aerobic sewage only is suitable for treatment in the aeration tanks without odor production. This can be accomplished but considerable study and experimentation may be necessary to determine the most satisfactory points and most economical methods of application of chlorine.

In addition to a program of sewage chlorination three improvements might be made at the present plant. The first of these involves

(*) Chlorination in Sewage Disposal. Report of the Committee on Sewage Disposal, A. P. H. A. Technical Reprint No. 464, Wallace and Tiernan Co. Inc.

the disposal of the supernatant overflow from the digesters. This material should not be returned to the plant influent. It could better be discharged either into the secondary settling tank outlet to the dosing tanks or into the final settling tanks. Provision should be made for the chlorination of this material before its discharge into either the dosing or final settling tanks so that when its H_2S content is high, odors from this source could be prevented.

The second very apparent need at the plant is a correction of the air distribution in the aeration tanks and channels. As long as straight aeration of the sewage without sludge return is practiced and the suspended solids content in the tanks is relatively low, no great damage is caused by the unequal air distribution. However, the oxidation efficiency is reduced and more air is being used than necessary. The present condition moreover would become a greater source of odor as soon as sludge began to settle out in any of the aeration tanks. Also, if an activated sludge should be developed due to corrective measures applied to the incoming sewage, it is very doubtful whether the tanks could be operated satisfactorily until the air distribution had been satisfactorily adjusted.

The third point for possible improvement concerns the operation of the sprinkling filters. It has been shown that there is a direct correlation between the filter loadings in pounds of B.O.D. and the intensity of the odors produced. During the summer months filter rates of three million gallons per acre per day or less, invariably produce considerable odor.

An experiment to determine the effect of returning final effluent

to the dosing tanks when the filter rate is three million gallons per acre per day or less is suggested. This procedure might be tried by installing, temporarily, a pump and line from the final effluent to the nearest dosing tank and operating one filter by diluting its influent with plant effluent. This experiment could be undertaken, as suggested, during the summer when the sewage is most highly concentrated and the results compared, as regards to effluent quality and odors produced, with those from the other two filters operated as at present.

The procedure of returning the sprinkling filter or final effluent to the raw sewage is not recommended. This practice would most likely result in protein deamination and the release of gaseous nitrogen with the production of floating sludge in the primary and secondary settling tanks and all of its attendant difficulties.

In conclusion it may be suggested that to properly carry out the sewage septicity, chlorination and sludge development studies proposed, it may be necessary to employ, temporarily, an additional chemist, preferably one with experience in biological treatment processes and with the factors and effects involved in this study. It will also be necessary to provide a reliable sample collector and adequate facilities for collecting fairly large samples and rushing these to the laboratory daily at the time they are needed. Details of the procedure to be followed in the experimental development of activated sludge and in the biochemical oxygen demand removal efficiency tests therewith, would be furnished by this station of the Public Health Service if such information is desired.

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TABLE I.

SUMMARY OF THE YEARLY MEAN HYDROGEN SULPHIDE RESULTS
AT FORT WORTH, TEX.

P.P.M. - H_2S				
Average	Oct. 1933 to 1934	Oct. 1934 to 1935	Oct. 1935 to 1936	1936 - 1937
Raw Sewage	4.5	3.7	4.1	4.3
Imhoff Effluent	8.9	7.0	6.0	
Primary Tank Ef- fluent				3.4
Aeration Tank Ef- fluent	2.4	1.9*	Not Operated	1.3 ^a
Secondary Tank Ef- fluent	3.7	3.0*	" "	3.3*
Sprinkling Filter Ef- fluent	.05	0.1	0.1	0.2
Final Clarifier	.05	0.1	0.1	0.2
Digester Supernatant Overflow	- -	36.5	43.5	22.4
Secondary Basin Sludge		5.0		
Final Clarifier Sludge		0.6	1.5	1.5

* Operated for three months only.

^a Operated for nine months only.

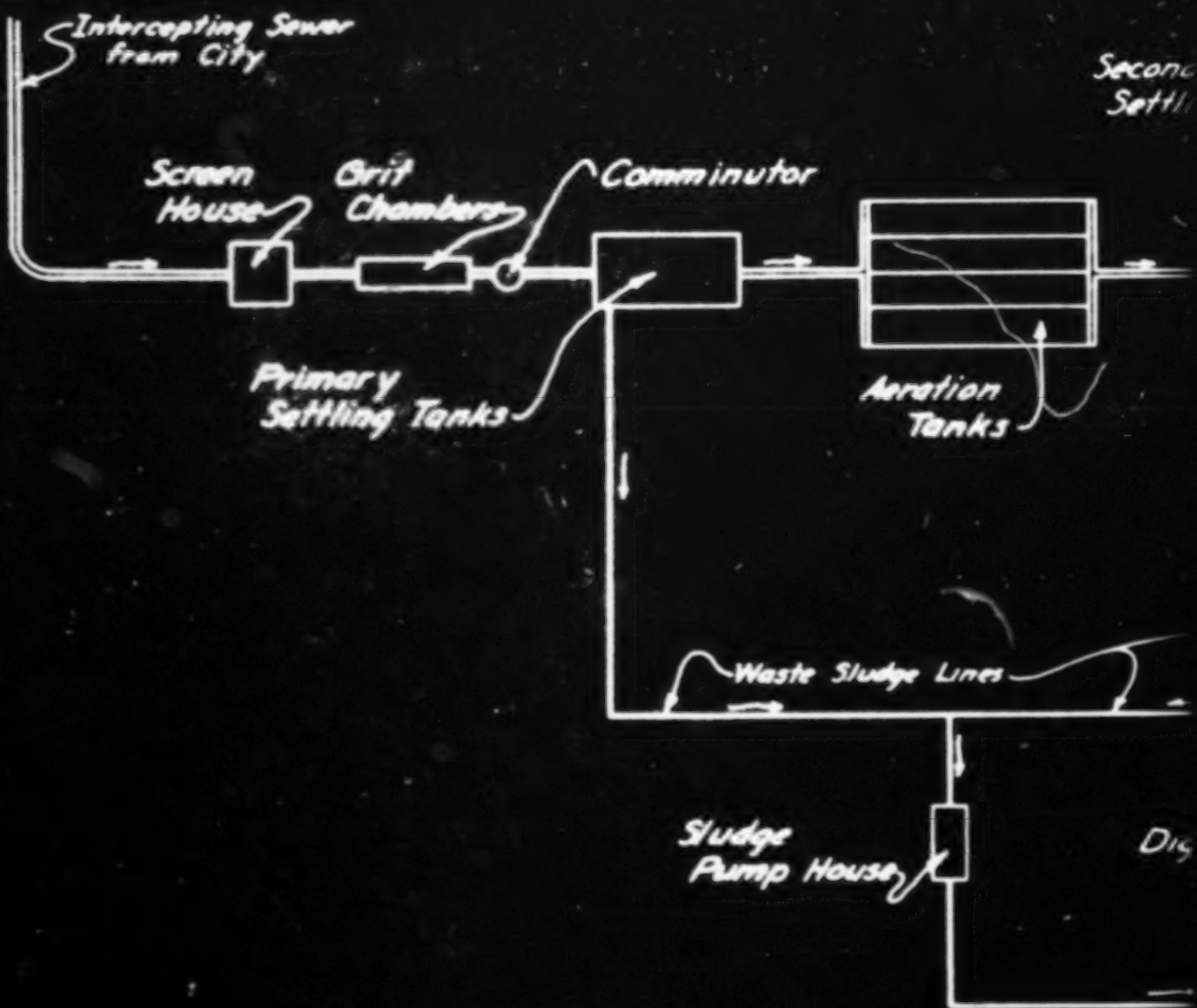
TABLE II.

HYDROGEN SULPHIDE AND ODOR INTENSITY INDEX RECORD, PRINCIPAL
ODOR PRODUCING PLANT UNITS FOR THE YEAR OCT. 1, 1936 TO SEPT. 30, 1937.

Month	Primary Tanks		Aeration Tanks		Secondary Tanks		Sprinkling Filters	
	H ₂ S in ef- fluent p.p.m.	Odor inten- sity Index	H ₂ S in ef- fluent p.p.m.	Odor inten- sity Index	H ₂ S in ef- fluent p.p.m.	Odor inten- sity Index	H ₂ S in ef- fluent p.p.m.	Odor inten- sity Index
1936								
October	4.6	55.4					0.1	67.7
November	2.2	35.0					0.1	87.2
December	1.5	33.8					0.1	65.6
1937								
January	1.0	32.8	0.3	36.0			0.2	62.4
February	1.5	33.3	0.4	41.6			0.3	66.7
March	0.6	32.8	0.2	36.5			0.2	64.0
April	2.2	33.3	0.4	56.1			0.3	71.6
May	5.3	33.9	0.8	77.9			0.4	68.6
June	3.9	31.6	0.6	61.4			0.2	68.9
July	4.6	33.3	1.8	67.7	1.9	32.8	0.2	63.8
August	6.5	36.1	3.7	71.1	3.8	37.2	0.2	91.1
September	6.4	36.1	3.9	65.0	4.3	56.0	0.2	93.3
Mean	3.4	35.6	1.3	57.4	3.3	42.0	0.2	72.6
Maximum	6.5	55.4	3.9	77.6	4.3	56.0	0.4	93.3
Minimum	0.6	31.6	0.2	36.0	1.9	32.8	0.1	62.4

The plant units were not operating during periods when data are not given.

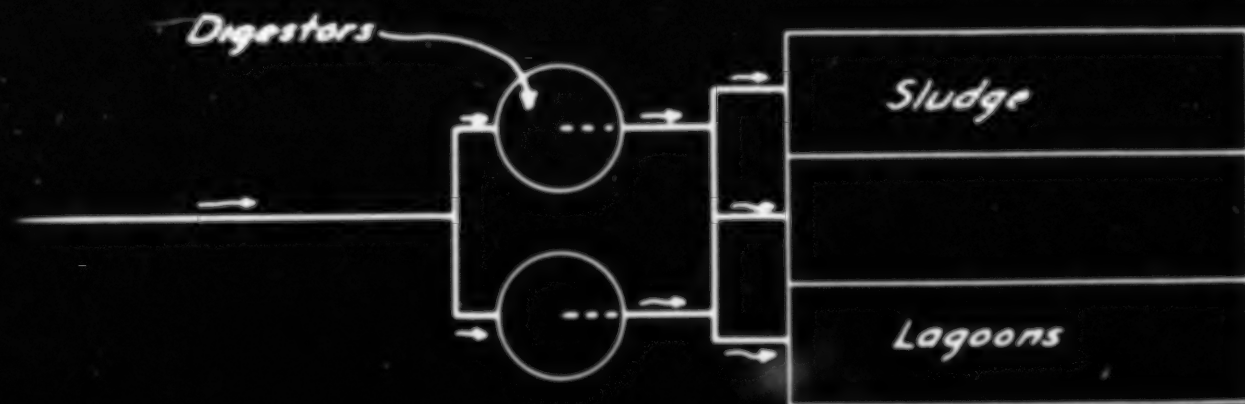
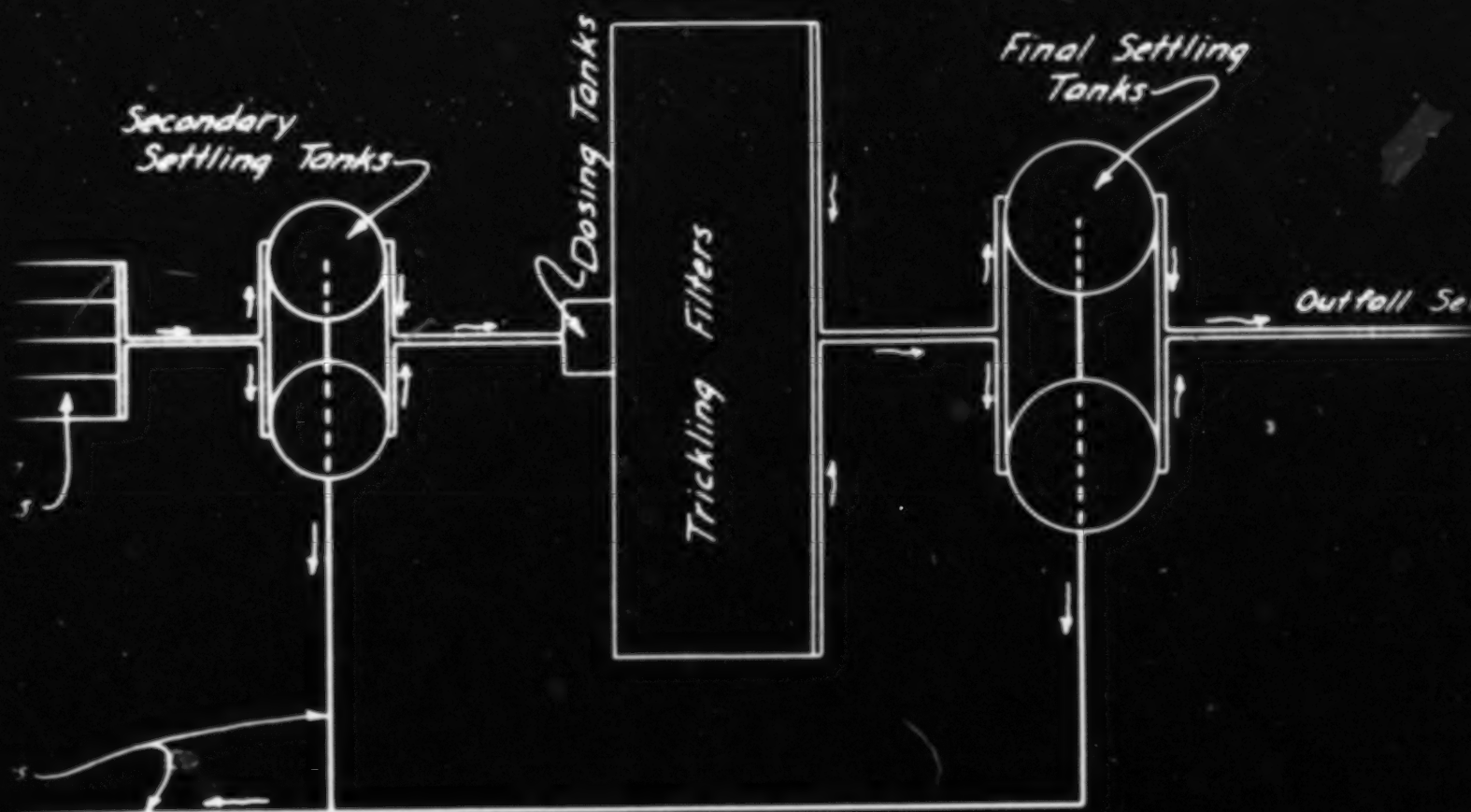
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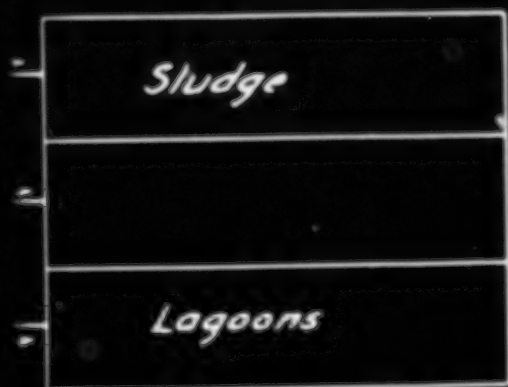
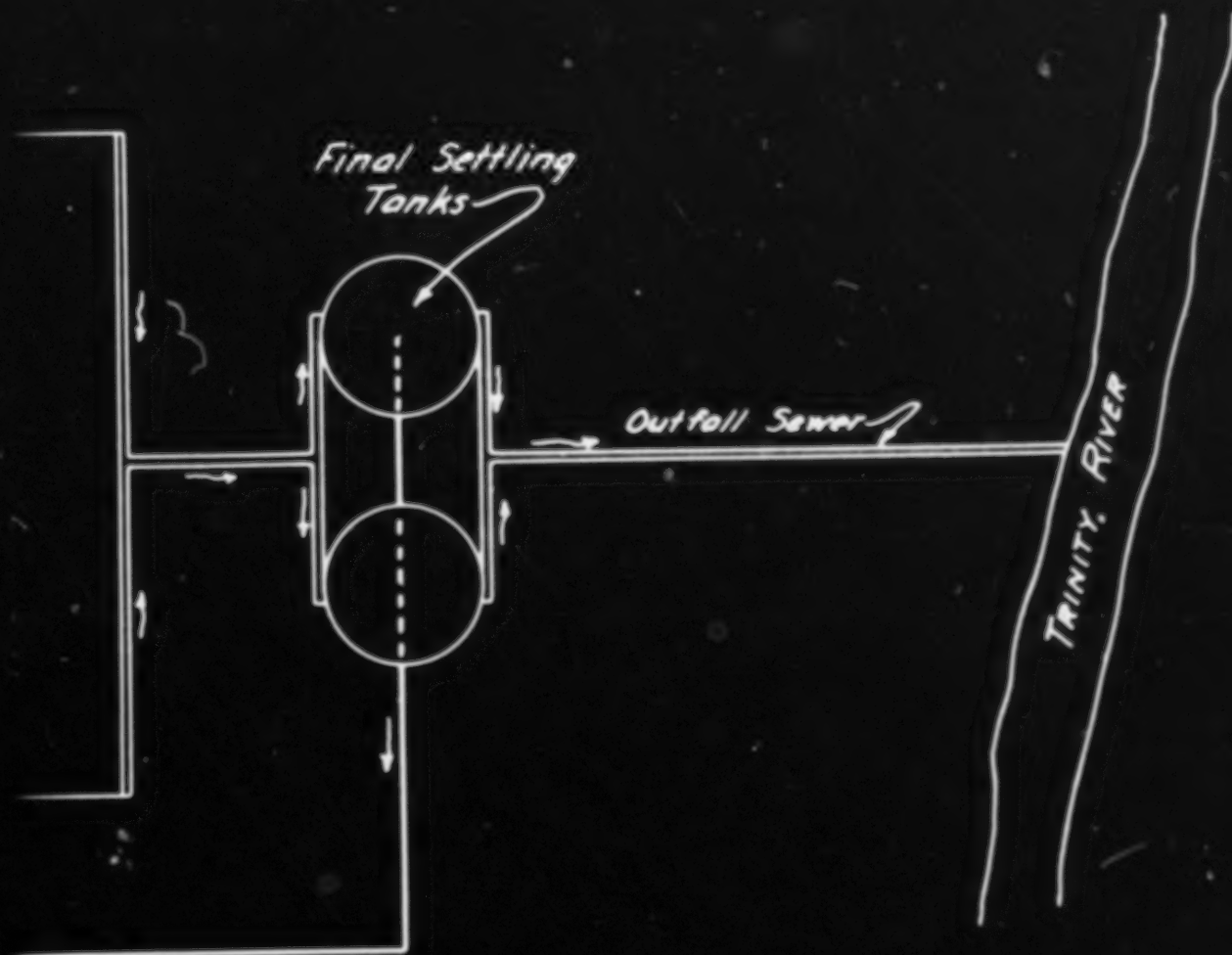


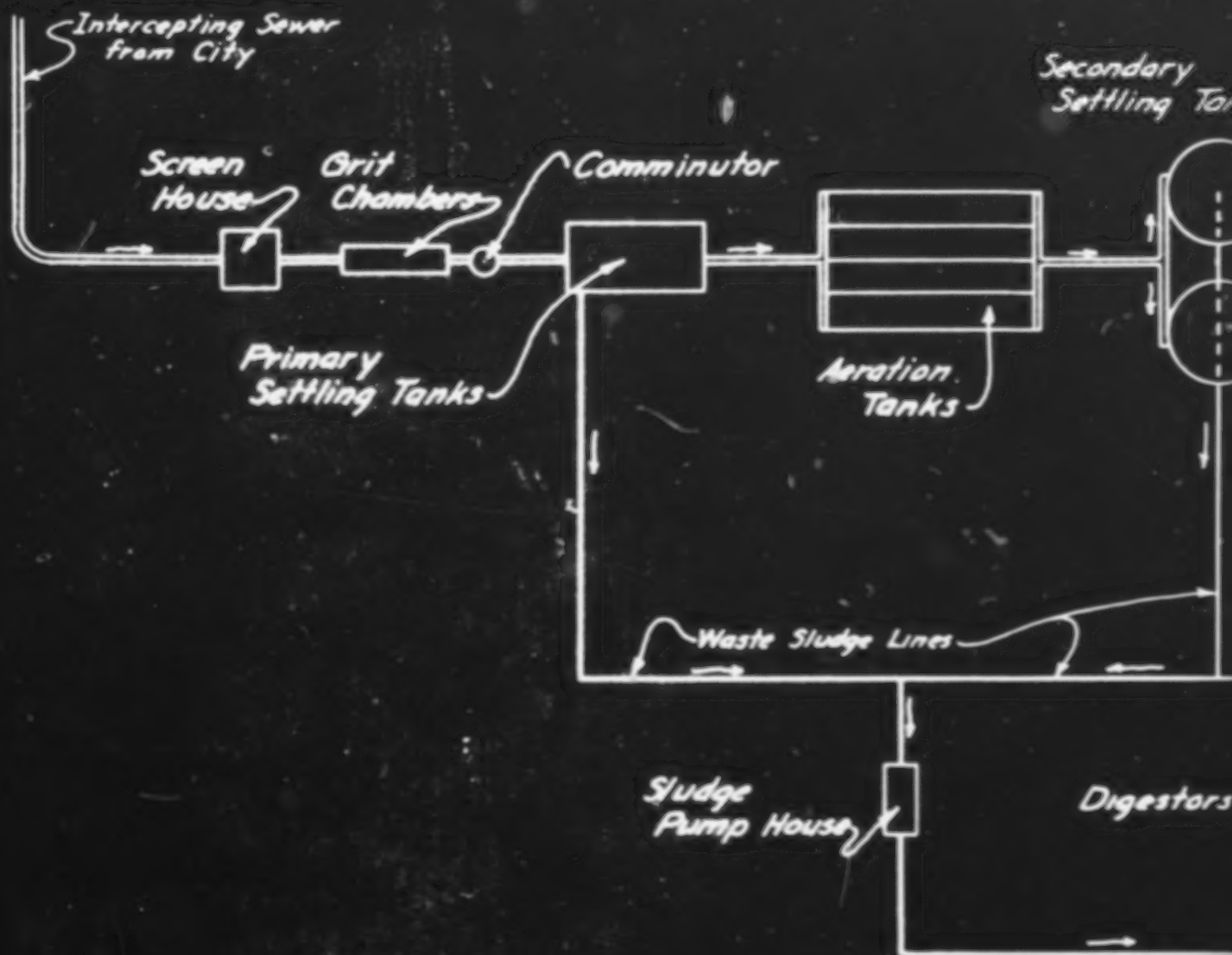
Note:

No sludge return to Aeration Tanks -

Sludge Process

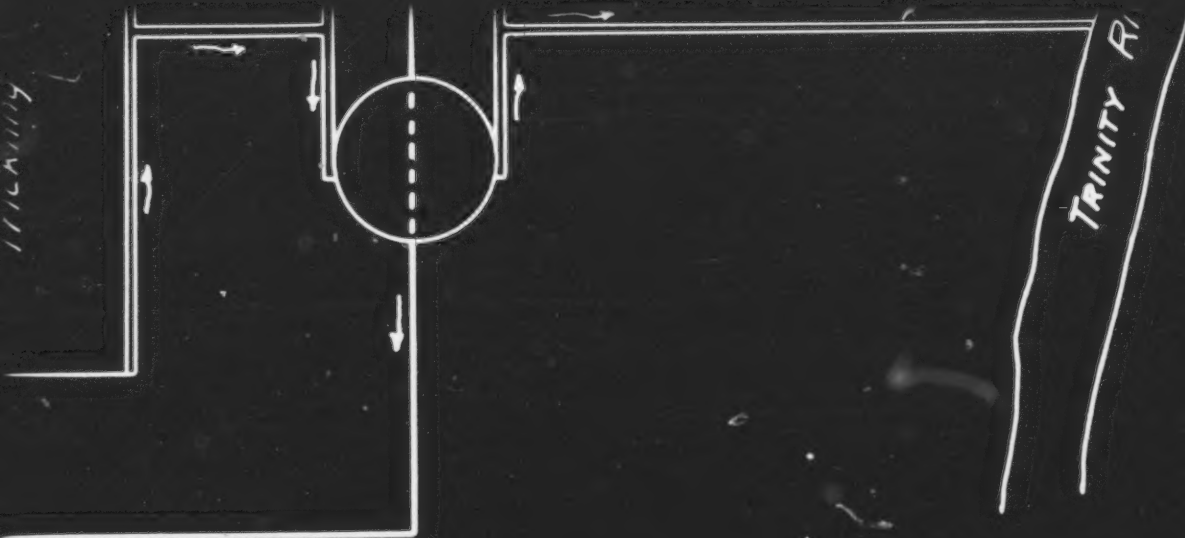






Note:

No sludge return to Aeration Tanks -
not using Activated Sludge Process.



U.S. Public Health Service
Stream Pollution Investigations Sta.
Cincinnati Ohio
Fort Worth, Texas
Sewage Treatment Plant
1937-1938 Flow Diagram
Feb. 18, 1938

R. L. Hunt